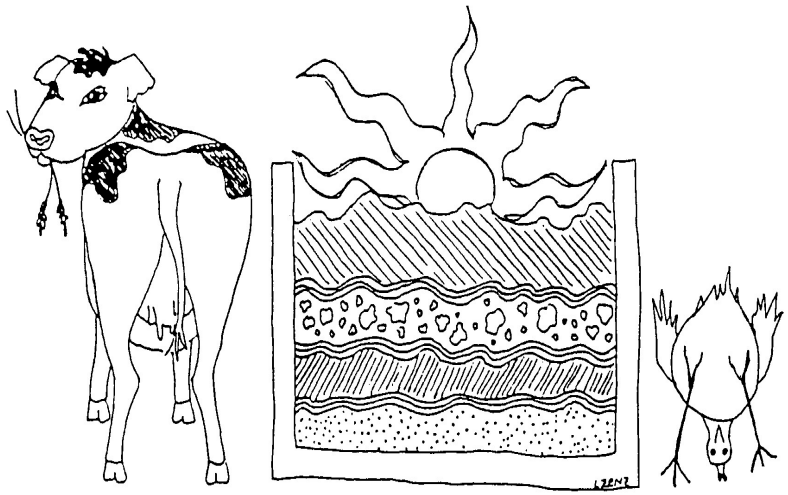
From End to Beginning



A *Manure Resource Guide* for farmers and gardeners in western Washington

King County Agriculture Commission

The **Manure Resource Guide** is available through:

King Conservation District
935 Powell Ave SW
Renton, WA 98055
(206) 764-3410

Washington State University Cooperative Extension:

King County
700 Fifth Ave, Suite 3700
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And On-line at:
http://agsyst.wsu.edu/manure.htm

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From End to Beginning

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PART I

Manure as a Resource

In King and Pierce Counties, approximately 40,000 beef and dairy cattle and over 1 million chickens are produced annually, with a combined market value of over $106 million[1]. In King County alone, more than 528,000 tons of manure are generated each year by dairy and beef cows, horses, pigs, and sheep. This is enough manure to fertilize 42,000 acres of sweet corn.

Agricultural production trends in King and Pierce Counties have followed the national trends; agriculture has become more specialized and livestock production has become concentrated on smaller acreages, often separate from crop production. This situation has created a manure surplus for livestock farmers who must now utilize containment systems to manage manure in order to maintain clean and healthy water resources in the region. Meanwhile, crop farmers have come to rely almost exclusively on chemical fertilizers for plant nutrient inputs.

The purpose of this guide is to help link people (crop farmers, gardeners) who can benefit from the valuable nutrient resource of manure with livestock producers who supply more manure than they can use on their own farms. Additionally, this guide contains information on how to apply appropriate amounts of manure to various crops. To calculate exact manure application rates it is essential that, prior to manure application, the manure and the soil to which it will be applied are tested to determine the nutrient levels in each. In the absence of these exact test results, we have included a table of national averages of manure nutrient values to be used as a guide for estimating how much manure to apply for crop production.

Nutrient Values of Manure

Before the widespread use of chemical fertilizers, animal manures were used as a primary source of nutrients in crop production. In addition to supplying plant nutrients to the soil, manure also improves soil health by increasing soil organic matter and promoting beneficial organisms. Incorporating manure into a field will help to reduce water and wind erosion by improving soil structure[2].

Livestock manure contains a broader range of nutrients than most commercial fertilizers. This is because a large portion of the plant nutrients initially ingested by the animals - generally 80% of the phosphorus, 90% of the potassium and 75% of the nitrogen[3] - are still present in the manure. Nutrient availability, however, is determined by the manure handling system, as well as by climate and soil characteristics. Nutrient values also vary with different types of livestock and the animal feed rations, which vary with the season. Generally, poultry manure tends to be high in nitrogen (N) and phosphorus (P), while dairy manure tends to be high in potassium (K). The national averages of manure nutrient values are given in Table 1.

Table 1: National averages of nitrogen (N), phosphorus (P_20_5), and potassium (K_2O) values of manures based on a dry weight and a wet weight basis.*

	%	% Dry Weight			% Wet Weight		
Source	Dry Matter	Total N	Total P_2O_5	Total K_2O	Total N	Total P_2O_5	Total K_2O
Dairy	15-25	0.6-2.1	0.7-1.1	2.4-3.6	0.1-0.5	0.1-0.3	0.4-0.9
Feedlot	20-40	1.0-2.5	0.9-1.6	2.4-3.6	0.2-1.0	0.2-0.6	0.5-1.4
Horse	16-25	1.7-3.0	0.7-1.2	1.2-2.2	0.3-0.8	0.1-0.3	0.2-0.6
Poultry	20-30	2.0-4.5	4.5-5.0	1.2-2.4	0.4-1.4	0.9-1.5	0.2-0.7
Sheep	25-35	3.0-4.0	1.2-1.6	3.0-4.0	0.8-1.4	0.3-0.6	0.8-1.4
Swine	20-30	3.0-4.0	0.4-0.6	0.5-1.0	0.6-1.2	0.1-0.2	0.1-0.3

*To determine actual amounts of nutrients, however, it is necessary to have the manure tested. **Source:** Knott's Handbook for Vegetable Growers. 1997. John Wiley & Sons, Inc.[4]

In a recent study of 51 dairies in the Willamette Valley, manure nutrient values of dry stack (piled, un-separated manure) and separated solids or screenings, (manure solids screened from the liquids) were determined (Table 2). In comparing the two tables, we can see that the average nutrient content of dairy manure in the Willamette Valley was approximately equal to the national average.

Because dairy manure is high in potassium, over-applications of this type of manure should be avoided because of plant and animal toxicity problems linked to excess potassium uptake.

Table 2: Average nutrient values of dairy manure from 51 dairies in the Willamette Valley, on a dry weight and a wet weight basis.

	%	% Dry Weight			% Wet Weight		
Manure Type	Dry Matter	Total N	Total P_2O_5	Total K_2O	Total N	Total P_2O_5	Total K_2O
Dry Stack	20	2.5	2.5	4.0	0.5	0.5	0.8
Separated solids/ screenings	20	1.25	0.5	0.5	0.25	0.1	0.1
Average	20	1.9	1.5	2.3	0.4	0.3	0.5

Source: Nutrient Management for Dairy Production: Dairy Manure as a Fertilizer Source. 1995. OSU Extension Service Publication EM 8586.[5]

Within the dairies in the Willamette Valley, there was quite a bit of difference in nutrient value between the dry stack and the separated solids/screenings. The dry stack dairy manure contained twice as much nitrogen, 4 times as much phosphorus, and 8 times as much potassium as the separated solids/screenings.

The manure handling/storage system affects the nutrient value and balance of the manure. Nutrient values will change depending on whether the manure was flushed out of the barn with water (flushing will dilute nutrient content) or scraped. It is also important to know if the manure was stored in a lagoon, storage tank, or barn/shed to accurately estimate nutrient values.

When applying separated solids/screenings, it is necessary to calculate application rates based on *nitrogen* whereas when applying dry stack manure, it is necessary to pay greater attention to *phosphorus* and *potassium* accumulation in the soil. Manure applications should be reduced when necessary. It takes less dry stack manure to supply the crop nutrients and so it should be applied at a lower rate than the separated solids/screenings.

The nutrient values presented in Tables 1 and 2 are given on a dry weight *and* a wet weight basis. Manure test results generally list nutrient values on a *dry weight* basis, but when manure is picked up, delivered, and applied, it is at least 60-80% water and so it is necessary to know the nutrient values on a *wet weight* basis. Both the dry weight and the wet weight nutrient values are included in this guide to help you calculate the amount of nutrients that are applied in manure.

Example 1

To convert a *dry* weight value to a *wet* weight value, multiply the percent N, P, or K on a dry weight basis by the percent dry matter.

Example using Table 2:

Percent N in dry stack manure on a dry weight basis is 2.5%
Percent dry matter is 20%
20% in decimal form is 0.20

% N on a dry weight basis x % dry matter

2.5% x 0.20 = 0.5%

Using this equation, we can see that the percent of N in this manure on a wet weight basis is 0.5%.

In addition to a manure test, a background soil test should also be conducted before applying manure to a field. The Oregon State University Extension Service pamphlet, EC 628, entitled *"How to take a soil sample... and why"* is available at your local WSU Extension Office. Fields should be tested

each year to monitor soil nutrient levels and to avoid over-applications that might threaten water quality or livestock health. This is important because applying dairy manure to a field for many years can result in high soil potassium levels. Elevated levels of potassium in the soil can accumulate in forages and cause stress to livestock consuming these crops, especially dairy cows. This is why it is necessary to test the amount of potassium available in the soil and the forage *before* applying manure[6].

Calculating Manure Application Rates

Appropriate manure application rates depend on the nutrient values of the manure and the soil, as well as the nutrient applications recommended for specific crops. Manure and soil samples should be analyzed to determine actual nutrient values. Several labs that conduct these analyses are listed in the *Resources* section of this guide. To help determine the amount of manure to apply to a field, Table 3 provides suggested nitrogen (N), phosphorus (P), and potassium (K) application rates for specific vegetable crops. Fertilizer guides for specific crops are available from your local Cooperative Extension office - see *Resources* section.

A simple way to calculate the manure application rate is to base it on the *nitrogen* requirements for each crop. It is important to note that not all of the nitrogen in the manure will be available for crop growth the first year of application (generally 50% will be available in the first year). But if manure is applied every year for a 3-5 year period, this calculation method can be used to adequately determine how much nitrogen should be added each year. For a detailed description of how to calculate manure application rates, refer to the Pacific Northwest Cooperative Extension publication, *How to Calculate Manure Application Rates in the Pacific Northwest* (see *Resources* section). This publication provides equations that take into account soil drainage, nutrient availability to plants, and denitrification in determining application rates.

When calculating the amount of manure to apply for crop growth, make sure that the amounts of P and K will not be applied at excessive rates. If the calculation results in an over-application of P or K, recalculate the amount based on P or K and supplement the crop with nitrogen.

Example 2

Calculate the manure application rate for a crop of carrots on soil that has tested medium in P and high in K (Table 3). Assume we have dry stack dairy manure (Table 2):

	Pounds per Acre (lb./A)		
	N	**P**	**K**
Fertilizer rate for carrots	50	100	50
Dry stack manure nutrient value	0.5%	0.5%	0.8%

The amount of manure needed to supply 50 pounds per acre of N:
50 lb./A N ÷ 0.5% (or 0.005) N/lb. manure = 10,000 lb./A manure

The amount of P provided by this manure application rate will be:
10,000 lb./A manure X 0.5% (or 0.005) P/lb. manure = 50 lb./A P

The amount of K provided by this manure application rate will be:
10,000 lb./A manure X 0.8 % (or 0.008) K/lb. manure = 80 lb./A K

This manure application will supply:
50 pounds per acre of nitrogen (N)
50 pounds per acre of phosphorus (P)
80 pounds per acre of potassium (K)

Using Example 2, we can see that if this particular manure is applied based on *nitrogen* requirements, it will supply the necessary amount of nitrogen, but it will provide insufficient P and an excess of K. It will be necessary to additionally supplement the P levels to obtain the recommended application

rate of 100 pounds per acre. It will also be necessary to re-test this soil after a few years of successive manure applications to make sure that K levels do not go too high. As mentioned before, applying an excess of K could lead to plant and forage toxicity problems for livestock. If soil tests indicate a very high K level, the manure applications should be stopped and N and P should be supplied from non-manure sources such as compost or green manures to meet the recommended crop nutrition levels. Similarly, if soil tests show very high levels of phosphorus, manure should not be applied. Over applications of phosphorus to land that slopes towards surface water such as streams, rivers, ponds, or lakes, can cause eutrophication, an abundance of aquatic plants and a deficiency in oxygen, resulting in water pollution.

Avoid applying manure on slopes during heavy rains or when ground is frozen.

Manure Application

Manure application rates should be specific to the crops and soil, and applications should be scheduled to fit the farming operation and the season. The application rate should be carefully estimated because if it is excessive, it can cause pollution of surface and groundwater, toxicity to livestock consuming the crops, and contribute to problems with plant growth. Applications should also be timed to avoid spreading in winter and early spring; frozen ground and rainfall lead to runoff and leaching of nutrients into water resources where they become pollutants.

Methods of application include a conventional beater-spreader, liquid tank wagon, large bore irrigation nozzle (for liquids), and/or a shovel and pitch fork. The "big-gun" sprinkler applications should be avoided because they offer the least accuracy and control when applying liquid manure to a specific area. Tank-type spreaders, on the other hand, provide the most accuracy and control.[7]

Example 3

To convert application rates in *acres* to application rates in *square feet* (as for a garden or small farm) remember that:

1 acre = 43,560 square feet

Scenario: The plot of carrots you want to fertilize is 10 square feet. Based on soil and manure nutrient tests, the recommended application rate to supply 50 pounds of nitrogen per acre is 10,000 lbs/acre of dry stack dairy manure (see Example 2). Since you only want to fertilize 10 square feet, use the following equation to calculate manure application rate:

$$\frac{\text{Application rate of manure lbs/acre}}{\text{43,560 sq.ft/acre}} = \text{lbs of manure/sq.ft}$$

Then multiply the *pounds of manure per square foot* by *the number of square feet that you want to fertilize* to get the *total weight of manure to be applied.*

Using our scenario:

$$\frac{\text{10,000 lbs of dry stack dairy manure/acre}}{\text{43,560 sq.ft/acre}} = 0.23 \text{ lbs manure/sq.ft}$$

0.23 lbs manure/sq. ft x 10 sq.ft = 2.3 lbs manure for 10 sq.ft

To fertilize a 10 square foot plot of carrots based on nitrogen requirements, you would need a total of 2.3 pounds of dry stack dairy manure. This amount would them be applied at a rate of 0.23 pounds of manure per square foot.

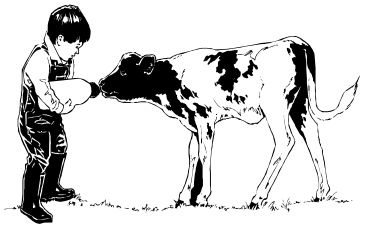
Manure should be applied to flat land whenever possible and be incorporated into the soil shortly after spreading to reduce loss of nitrogen. The rate of manure application should decrease as slope increases. Vegetative buffer strips at the base of the slope can prevent runoff of nutrients on sloped land.

Whenever manure is applied to your land, it is important to keep good records of the date, amount applied, nutrient content, soil test results, weather conditions, as well as any other notes that would be helpful to have in the future. These records can be used to determine future application rates and also

to provide documentation of applications if questions or issues arise in the future. Your records may also make note of water sources in and around the area of application, and include any precautionary measures taken to avoid water contamination.

Food Safety and Manure

Whenever manure is applied to food crops, safety precautions should be taken to avoid contamination that might result in human illness. The pathogens of most concern that can be found in livestock manure are E. coli and Salmonella. To avoid the risk of contamination, fresh manure should not be applied within 60 days of harvesting food crops. In fact, fresh manure, especially if it is from young animals such as dairy calves, should always be used with extreme caution and should be composted to reduce potential of disease pathogens.[8]



Manure from young calves should not be applied to fertilize food crops because of the possible pathogens that may be present in their manure.

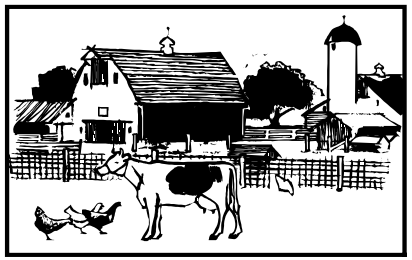
The composting of manure is a simple way to reduce the risk of contaminating food crops. This is because the survival of disease pathogens depends largely on pH, moisture content, temperature, and oxygen levels. [8] We will be discussing composting in greater detail in Part II of this guide.

To prevent contamination of ground water, every attempt should be made to reduce the risk of surface and ground water contamination by manure. Surface water contamination can be reduced by *not* applying manure when the ground is frozen, when plants are dormant, and during periods of heavy rains or floods. In addition, avoid manure application in riparian areas. To avoid groundwater contamination, manure should not be applied between October and March (months of high rainfall), near wells, and should not be over-applied.

Vegetative buffer strips can be used to help trap and uptake nutrients before they are washed away. These buffer strips, planted or maintained between the land that is fertilized and water sources, should be at least 2 feet wide. Buffer strips are especially beneficial on slopes or in riparian areas. [8]

Altogether, the best way to prevent your food crops and nearby water sources from being contaminated by potential pathogens in livestock manure is to: 1) avoid using fresh manure that has come from young animals, especially dairy calves; 2) compost manure to kill any pathogens that may be present; 3) use buffer strips on your property to reduce chance of nutrient loss and water contamination; and 4) time the manure application appropriately to avoid excessive leaching or runoff. It is also important to note that food crops, fruits and vegetables in particular, should be thoroughly washed prior to eating or marketing. This simple step can significantly reduce the possibility of spreading manure-borne pathogens[8].

PART II



On-Farm Composting

Composting manure is both an art and a science. Proper ratios of raw materials and careful monitoring of moisture and temperature can turn a pile of manure into a pile of rich, fertile humus. Composting reduces the volume of manure by approximately 50%, making it easier and more efficient to apply to crop land[9]. It also kills most pathogens and weed seeds and results in a nutrient packed product that can be used as a soil conditioner or soil amendment.

Nutrients in composted animal manure are more stable than fresh manure, and are less likely to be leached or tied up. Composted manure also releases

nitrogen, phosphorus, potassium, and other nutrients more slowly than fresh manure, thus providing a continuous supply of nutrients to the plants. Compost improves the activity of beneficial microorganisms that create humus and adds fertility to the soil. Moisture levels, temperature, and carbon and nitrogen ratios of materials need to be monitored for maximum composting efficiency - see *Important Factors in Composting*.

In addition to composting manure, you can also incorporate plant material, animal bedding, weeds (not at seed stage), yard residues, and kitchen scraps into the compost pile (Table 4). Generally, it is not recommended to compost meat products because they will attract animals to the compost pile. However, for information about composting livestock mortalities, visit the WSU Cooperative Extension Agricultural Systems Livestock web site online at: http://agsyst.wsu.edu/livestck.htm and click on the Sustainable Farming Connection Livestock Menu.

Compost piles should be kept under a roof or covered with a tarp to maintain temperature levels, reduce leaching or runoff of nutrients, and maintain acceptable moisture levels -- especially during the wettest months. Composted manure should not be applied from October through March as high rainfall during these months can lead to runoff and nutrient leaching.

Table 4: Carbon to nitrogen ratios for selected materials*

Materials with High Nitrogen Values	**C:N**
Poultry manure with litter	13-18:1
Vegetable waste	12-20:1
Pig manure solids	15-25:1
Dairy manure	20:1
Material with High Carbon Values	**C:N**
Wood chips and sawdust	100-500:1
Paper	150-200:1
Straw	40-100:1
Foliage (green)	30-80:1
Material with Neutral C:N Ratios	
Horse manure with litter	30-60:1

*Because manure content varies, C:N ratios may vary. Manure should be tested to determine actual values. **Source:** B.C. Agricultural Composting Handbook. 1998. Ministry of Agriculture and Food.

What is Composting?

Composting is a biological process that utilizes heat, moisture, oxygen, and microbial organisms such as bacteria and fungi to decompose plant and animal matter. This decomposition process breaks down raw materials into a nutrient rich organic matter that farmers can apply as a fertilizer or soil conditioner to crops and pastures. For typical nutrient breakdown of finished compost see Table 5.

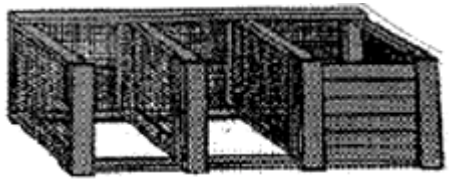
Table 5: Typical nutrient breakdown of finished compost

Nutrient	**Dry Weight**
Nitrogen (N)	<1% up to 4.5%
Potassium (K_20)	0.5% to 1%
Phosphorus (P_20_5)	0.8% to 1%
Calcium (Ca)	2% to 3%
Magnesium (Mg)	2% to 3%

Source: B.C. Agricultural Composting Handbook. 1998.

The initial stage of composting usually takes about 2 months. The temperatures during this time should be maintained at 120-150°F by regularly turning the pile. Turning the pile, also called aerating, supplies the oxygen necessary for the microorganisms to actively decompose plant and animal materials. Aeration can be achieved by turning the pile with a pitchfork or front-loader, or by using a blower.

After the initial phase of composting is completed (when the compost pile has shrunk to 50% of its original size), the compost should be allowed to "cure" for approximately 60 days. The curing phase is necessary because, although the initial organic matter may appear to be thoroughly decomposed, the microorganisms in the pile will remain active and thus keep decomposing and generating heat for at least 4-8 more weeks. If the compost is used without being allowed to cure, it could harm some plants, especially young plants or germinating seeds. The temperatures during the curing process should be kept between 80-110°F. Aeration will speed up the curing process but it is not essential. You will know when the curing phase is done when the pile doesn't generate any more heat after being turned.[10]



A small scale three-bin system of composting that is typically used to compost kitchen scraps and yard debris for use on home gardens. **Source**: On-Line at http://aggie-horticulture.tamu.edu/extension/compost/chapter3.html

Size of Compost Piles

Compost piles can be made on any scale but they typically range in size from as small as one cubic yard to windrow piles that are often 5-10 feet tall. Several types of containment systems can be used to make compost, but for larger operations, compost should be made in a windrow or large outdoor pile. There may be county regulations regarding the size and location of outdoor piles, so be sure to check with the proper officials *before* constructing a windrow type composting system. The method of composting will depend largely on the equipment available (tractor or pitchfork), the volume of raw materials that you have access to, and the amount of time and space you can dedicate to composting.

Turning windrows with a bucket loader.
Source: On-Farm Composting Handbook, p.26

Important Factors in Composting

The most important factors to remember while maintaining a compost pile are aeration, moisture, temperature, carbon to nitrogen (C:N) ratio, and protection. *Aeration* (turning or adding oxygen to the pile) is necessary because the compost microbes need oxygen while they are decomposing plant and animal material. Turning the compost pile will add air and speed up the composting process. The *moisture* level should be maintained at a level where the compost pile is about as moist as a wrung-out sponge (moist but not dripping wet). Too much water will hinder aeration.

The warmer the pile, the faster the decomposition, but generally the *temperature* in compost piles is kept at 120-150°F. A pile that is too hot or too cold will be slow to decompose.

The *C:N ratio* refers to the balance between carbon and nitrogen levels in the compost pile. Too high of a C:N ratio (C:N>60) will typically slow decomposition, while if the ratio is too low (C:N<20), excess nitrogen will be lost as ammonia. Compost piles should be *protected* from the effects of sun and rain. Piles can be covered with a mulch, tarp, or enclosed in a shed. If a pile gets too wet and cold (or too hot and dry), the microorganisms will not be able to function as efficiently.

Table 6: Carbon to nitrogen ratio of some finished composts*

Type	Range
Dairy manure compost	7-10:1
Horse manure compost	30-80:1
Poultry manure compost	7-10:1
Fish mortality compost	25- 35:1
Mushroom media compost	8- 27:1
Pig on litter compost	23- 43:1
Pig manure compost	12- 35:1
Municipal solid waste compost	7- 25:1

*Because every compost pile is different, and C:N ratios may vary, compost should be tested to determine actual values. **Source:** BC Agricultural Composting Handbook. 1998. Ministry of Agriculture and Food.

Characteristics of Finished Compost

While there are exceptions, most finished composts have:

- A crumbly texture that allows air to penetrate and holds moisture while allowing excess water to drain away.
- A brown to dark brown color.
- An earthy odor.
- A lack of mold, ammonia, and putrid smells.
- A carbon to nitrogen ratio less than 25:1 (see Tables 4 and 6).
- An adequate supply of nutrients (see Table 5)
- A freedom from pathogens and weed seeds.
- A content of at least 30-50% organic matter.
- A pH between 5.0 and 8.0.

Passively aerated windrow method for composting.
Source: On-Farm Composting Handbook, p.29

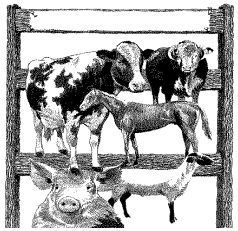
For a complete list of compostable and non-compostable materials refer to the WSU compost guides listed in the *Resources* section. The Ontario Ministry of Agriculture web site, also in the *Resources* section, provides guidelines for composting livestock mortalities. ***Before starting up a large-scale composting operation, contact your local Environmental Health division to find out about the rules and regulations governing composting in your area.***

Table 7: Troubleshooting Chart for Your Compost Pile

Symptoms	Problem	Solution
Has a bad odor	Not enough air	Aerate it. Add dry material if the pile is too wet
The interior of the pile is dry	Not enough water	Moisten and turn pile
The compost is damp and warm only in the middle	Compost pile is too small	Collect more material and mix it into the existing pile
The pile is damp and sweet-smelling, but still will not heat up	Lack of nitrogen	Mix in a nitrogen source such as manure
The compost pile is cold and wet	Too much rain or moisture	Cover with a mulch of finished compost or a tarp
The pile attracts flies, rodents, and pets	Not mixed well. Meat scraps may have been added to the pile	Do not add meat scraps. Mix the pile and cover with soil

Source: Compost: Put Back To The Earth What You Have Taken Out. OSU Cooperative Extension Pamphlet.

PART III



Conclusion

Manure is a valuable resource that can be used as a soil conditioner and source of plant nutrients to fertilize crops and stimulate plant growth. It is generally available at little or no cost, so it is accessible for even those people who do not have livestock on their own land, although there may be a charge if the manure is delivered. Because this guide is intended to help link manure producers to manure users, we have provided a list of some of the livestock owners that have surplus manure available in Part IV at the end of this guide.

Before applying manure it is important to have both the *manure* and the *soil* tested for nutrient content. This step is necessary because if too much potassium (K) is added to a field, it can cause plant and livestock toxicity problems. Once the manure and soil have been analyzed, the proper manure application rate can be determined using the charts we have provided in this guide.

Manure can be applied in many ways depending on the equipment that is available. “Big Gun” sprayers should be avoided if possible because they tend to provide little control to where and how much manure is applied. The preferred method of application is using a tank-type spreader which offers more precision. Manure applications should always be recorded and kept with the rest of farm records.

Food safety considerations should be a priority when utilizing manure to fertilize food crops, especially fruits and vegetables. E. coli and Salmonella are just two of the manure-borne pathogens that could contaminate food crops if manure application is handled improperly. To avoid any potential for contamination, it is best to avoid using manure from young animals, to compost manure before incorporating it into your soil, and to wash produce thoroughly before marketing or eating.

Composting is a good way to reduce the chance of pathogens in manure, but food scraps, yard waste, animal bedding, plant material, and weeds (not at seed stage) can also be incorporated into the pile. The finished compost, like manure, is used as a fertilizer, but is also employed as a soil conditioner to improve soil structure. Compost piles can range in size from one cubic yard in a bin to over 10-foot tall windrows. Whatever the size, the compost will still turn out the same when managed properly and will supplement crops equally well.

Whether composting or using manure on your farm, you can help contribute to the reuse and recycling of important nutrients and minerals by incorporating them back into food production. Using compost and manure also helps reduce unnecessary waste that could otherwise increase landfilling costs or contaminate ground water. To help facilitate the transition of manure from livestock farms to crop farms, in Part IV we have included a current list of farms in Thurston and Lewis counties that have manure available that can be picked up or delivered.

If these connections are made, the use of surplus manure benefits both parties; the livestock farmers will worry less about water contamination and holding systems, while crop farmers will not have to rely so heavily on commercial N-P-K fertilizer which is expensive when compared to free or low-cost manure. Our hope is that many people, farmers and gardeners alike, can take advantage of the resources that have been provided through this guide and use manure as a sustainable and low-cost means of supplying necessary crop nutrients.

PART IV
Manure Sources in King and Pierce Counties

King County Dept. of Natural Resources - Livestock Programs — Seattle — Manure Brokering
(206) 296-1471
King County DNR is currently compiling a list of livestock farmers who have surplus animal manure available. Call to be listed or to find out about manure sources.

King Conservation District — Renton — Manure Brokering
(206) 764-3410
Keeps an updated list of manure sources, big and small. Call to be listed or to inquire about manure sources.

Pierce Conservation District — Puyallup — Manure Brokering
(253) 845-9770
Keeps an updated list of manure sources, big and small. Call to be listed or to inquire about manure sources.

Manure Sources in Lewis and Thurston Counties

Temperstone District Inc. — Yelm area — Dairy Manure
(360) 894-3897
Covered & composted dairy manure, dry. 10yd delivery truck. Delivery area limited to Yelm, Rainier, McKenna & Roy. No on farm pick-up.

Hank Doelman — South Thurston County — Dairy Manure
call Thurston Conservation District (360) 754-3588
Uncovered dairy manure available. Allows 10yd trucks only.

Ralph Plowman — Yelm area — Dairy Manure
(360) 894-2738
Covered and composted dairy manure, dry. 10yd delivery truck. $60/hr. to haul. Delivery area limited to Yelm, Rainier, McKenna & Roy. No on-farm pick-up.

Dragt Dairy — Rochester — Dairy Manure
(360) 273-9558
Will haul and spread liquid manure for free within 4-5 miles of farm, on 5+ acres with good access.

Gerald Winter — South Thurston County — Dairy Manure
(360) 902-2590
Uncovered dairy manure solids. No pick-ups. 5yd truck minimum. May have to wait if loader is busy. Call first if there are unusual needs. Minimum charge (around $10 or less). Wednesdays are not good. Call to arrange delivery.

Master Gardener Dirtworks — Olympia — Dairy Manure
(360) 704-7781
Free - up to 10yrds at a given time. You load. Covered and fairly composted. Call first. Hours are limited.

Leo Zylstra — Onalaska — Dairy Manure
Misty Morning Dairy
(360) 985-2910
Fresh, separated dairy manure available. Call at least a day ahead of time to make arrangements. They will load and haul a 25yd truck for $6.00/yd but no half-loads. It is $5.00 for loading if you haul it yourself.

Harbor Environmental — Littlerock — Dairy Manure
(360) 412-1606 or (360) 753-5474 — Compost
Composted dairy manure for sale, $10/yd. U-haul or delivery available.

Bob Nix — Chehalis — Beef Manure
(360) 748-1372
Call ahead, he loads. $10.00 per pick-up load. Manure is composted, separated screenings.

John Stiebrs — Yelm — Chicken Manure
(360) 458-3333
Fresh chicken manure, he hauls, 16yd minimum. Call first. Call a day ahead and he'll load any size truck on site.

Hanson Farms — Winlock — Chicken Manure
(360) 785-3294
Fryer manure and sawdust, aged and fresh. You haul.

Nancy Allen — Olympia — Horse Manure
(360) 456-5434
Free horse manure. Has tractor, will load. Call ahead.

Luanne Stark — Olympia — Horse Manure
Miari Stables
(360) 786-1628
Has fresh and composted horse manure mixed with shavings. If appointment is made they will help load but will not haul.

Carol Jennings — Shelton & Olympia — Horse Manure
(360) 352-1700
Free horse manure. You load by hand. Limited amount (4 pick-up loads). Call to arrange.

Denise Penny — Boston Harbor — Horse Manure
(360) 943-0125
Free horse manure, mixed old and new. Can be tractor loaded by capable person, or else use hand shovels. Limited to 10-20yds.

Glenda Entsminger — Rainier — Horse Manure
(360) 264-4601
Call first.

Roger Hinck — Chehalis — Miniature Horse Manure
(360) 748-0714
Has miniature horse manure and shavings. Some of it is well composted and is good for small gardens. You load. No charge. Call ahead.

Denise Scott — Rochester — Composted (360) 273-4485 Horse Manure
You pick-up. Call first.

Dennis Felt — Centralia — Composted yard waste & gypsum
(360) 736-6673
Can mix in composted chicken manure. Soil amendment. Call for rates. U-haul or delivery available

Jim Jensen — Yelm — Worm Compost
(360) 894-0707 or (206) 622-9454
Also takes manure from folks who need to get rid of it. Call for details.

Bob Thode — Onalaska — Hauling
(360) 985-2347
Large quantity custom hauling, spreading, pumping. Land application from dairy lagoons, poultry operations. Call well in advance.

Thurston Conservation District — Manure Brokering
(360) 754-3588
Keeps an updated list of manure sources, big and small. Call to be listed or to inquire about manure sources.

PART V
Resources

The information provided here does not necessarily represent the official statements or views of Washington State University. These references are intended to provide additional information or resources to the reader and is not meant to be an endorsement of any of these businesses and shall not be used as such.

Organizations and Agencies that can Provide Information About Manure Resources:

King County WSU Cooperative Extension
700 Fifth Avenue, Suite 3700
Seattle, Washington 98104-5037
(206) 296-3900 or 1-800-325-6165 ext. 6-3900
http://king.wsu.edu/

King Conservation District
935 Powell Ave SW
Renton, Washington 98055
(206) 764-3410
http://www.kingcd.org/who/about.html

Pierce County WSU Cooperative Extension
3049 South 36th Street, Suite 300
Tacoma, Washington 98409
(253) 798-7180
http://www.pierce.wsu.edu/

Pierce County Conservation District
1011 East Main, Suite 106
Puyallup, Washington 98372
(253) 845-9770
http://www.piercecountycd.org

Laboratories Providing Testing Services:

For a more complete list of laboratories, please contact the King County WSU Cooperative Extension Service and request Agriculture and natural Resources Factsheet # 508.

Agri-Check, Inc.
323 Sixth Street, PO Box 1350, Umatilla, Oregon 97882
(541) 922-4894 or (800) 537-1129
Agricultural testing laboratory. Provides soil, manure and plant tissue analysis.

Cascade Analytical, Inc.
3019 G.S. Center Road, Wenatchee, WA 98801
(509) 662-1888
Provides soil, manure and plant tissue analysis. Will soon offer C:N testing for composting purposes.

Coffey Laboratories, Inc.
12423 NE Whitaker Way, Portland, OR 97230
(503) 254- 1794 FAX (503) 254-1452
Provides soil and plant tissue analysis.

Publications:

Analytical Laboratories and Consultants Serving Agriculture in the Pacific Northwest WSU Extension Bulletin No. 1578

Backyard Composting in the 1990's WSU Extension Bulletin No. 1784.

How to Take a Soil Sample ... and Why OSU Extension Bulletin EC628

Let It Rot! The Gardener's Guide to Composting by Stu Campbell was updated and revised in 1990. Storey Publishing.

Manure and Microbes: Public and Animal Health Problem? by Alice N. Pell. 1997. Department of Animal Sciences, Cornell University. Dairy Science 80:2673-2681.

Manure Management Guidelines for Western Washington A document designed to help managers develop, implement, and monitor a nutrient management plan. Available through the Soil Conservation District and WSU Cooperative Extension Whatcom County. Also available on-line at: http://whatcom.wsu.edu

On-Farm Composting Handbook by the Northeast Regional Agricultural Engineering Service. Cooperative Extension publication NRAES-54.

Pre-Sidedress Soil Nitrate Test (PSNT) OSU Bulletin No. 8650. Available at WSU Extension Offices.

The Rodale Book of Composting: Easy Methods for Every Gardener by Deborah Martin and Grace Gershuny is distributed by St. Martin's Press.

Web Sites:

WSU Food and Farm Connections Team: http://foodfarm.wsu.edu

WSU Cooperative Extension - Agricultural Systems: http://agsyst.wsu.edu

WSU Compost Connection Homepage: http://csanr.wsu.edu/compost

Listing of all WSU Cooperative Extension Offices by County: http://ext.wsu/ce.cahe/programs/ce.offices.html

Thurston Conservation District – http://wa.nacdnet.org/thurstoncd

*The Compost Resource Page***:** http://www.oldgrowth.org/compost/

Whatcom County Cooperative Extension: http://www.whatcom.wsu.edu/ag/dairy/dairy/htm

*Rot Web***:** http://net.indra.com/~topsoil/Compost_Menu.html

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA): http://www.gov.on.ca/OMAFRA/english/livestock/swine/facts/97-001.htm

References:

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2. Hermanson, Ronald E. Ph.D., P.E. 1996. *Manure Sampling for Nutrient Analysis with Worksheets for Calculating Fertilizer Values.* WSU Extension Bulletin No. 1819.

3. Brady, Nyle and Ray Weil. 1996. The Nature and Properties of Soils. Prentice Hall, New Jersey.

4. Maynard, Donald N., and George J. Hochmuth. 1997. Knott's Handbook For Vegetable Growers, Fourth Edition. John Wiley & Sons, Inc., New York.

5. Hart, J., M. Gangwer, M. Graham, and E. Marx. 1995. Nutrient Management for Dairy Production: Dairy Manure as a Fertilizer Source. OSU Extension Service publication EM 8586.

6. Paul, John and Lorne Fisher. 1994. Potassium Levels in Forages on Dairy Farms Reflect Manure and Fertilizer Applications. Agassiz Research Station Technical Report 97, Agriculture and Agri-Food Canada.

7. Peterson, Becky. 1995. Manure Management Guidelines for Western Washington. WSU Cooperative Extension - Whatcom County.

8. Pell, Alice N. 1997. Manure and Microbes: Public and Animal Health Problem? Dairy Science 80:2673-2681.

9. Martin, Deborah and Grace Gershuny. 1992. The Rodale Book of Composting. p 231. Rodale Press, Emmaus, PA.

10. Cogger, Craig G.; Sullivan, Dan M.; Duncan, Susan K. (1995, February). Backyard Composting in the 1990s [Online]. Available: http://coopext.cahe.wsu.edu/infopub/eb1784/eb1784.html [1999, June 23].

Information in Composting section was adapted from:

- *Compost: Put Back to the Earth What You Have Taken Out*. Oregon State University Cooperative Extension.
- Composting Fact Sheet - *The Composting Process*. B.C. Agricultural Composting Handbook 1998. Ministry of Agriculture.
- Composting Fact Sheet - *Using Compost*. B.C. Agricultural Composting Handbook. 1998. Ministry of Agriculture.
- "Composting Rules of Thumb." Price-Moon Enterprises, Inc. 127 Avenue A - Suite 2D Snohomish, WA 98290 (360) 563-6709
- *Essential Elements for Composting*. Oregon State University Cooperative Extension.
- Rynk, Robert. ed. On-Farm Composting Handbook. 1992. Northwest Regional Agricultural Engineering Service.